Lung Disease in Coffee Processing Workers

Board of Scientific Counselors

NIOSH Offices
Washington, DC 20201
March 30, 2016

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NIOSH Health Hazard Evaluation (HHE) request: coffee processing facility

- Received a confidential Health Hazard Evaluation request from workers at the coffee processing facility

- Health concerns: respiratory symptoms, lung disease, and eye irritation

Process: Roasting green coffee beans, grinding, and flavoring of whole beans and ground coffee, packaging flavored and unflavored roasted coffee

Sentinel cases of obliterative bronchiolitis in coffee processing workers

- **Five former workers**
  - Severe shortness of breath during employment at coffee facility
- **Two cases reported in Morbidity and Mortality Weekly Report (MMWR)[1]**

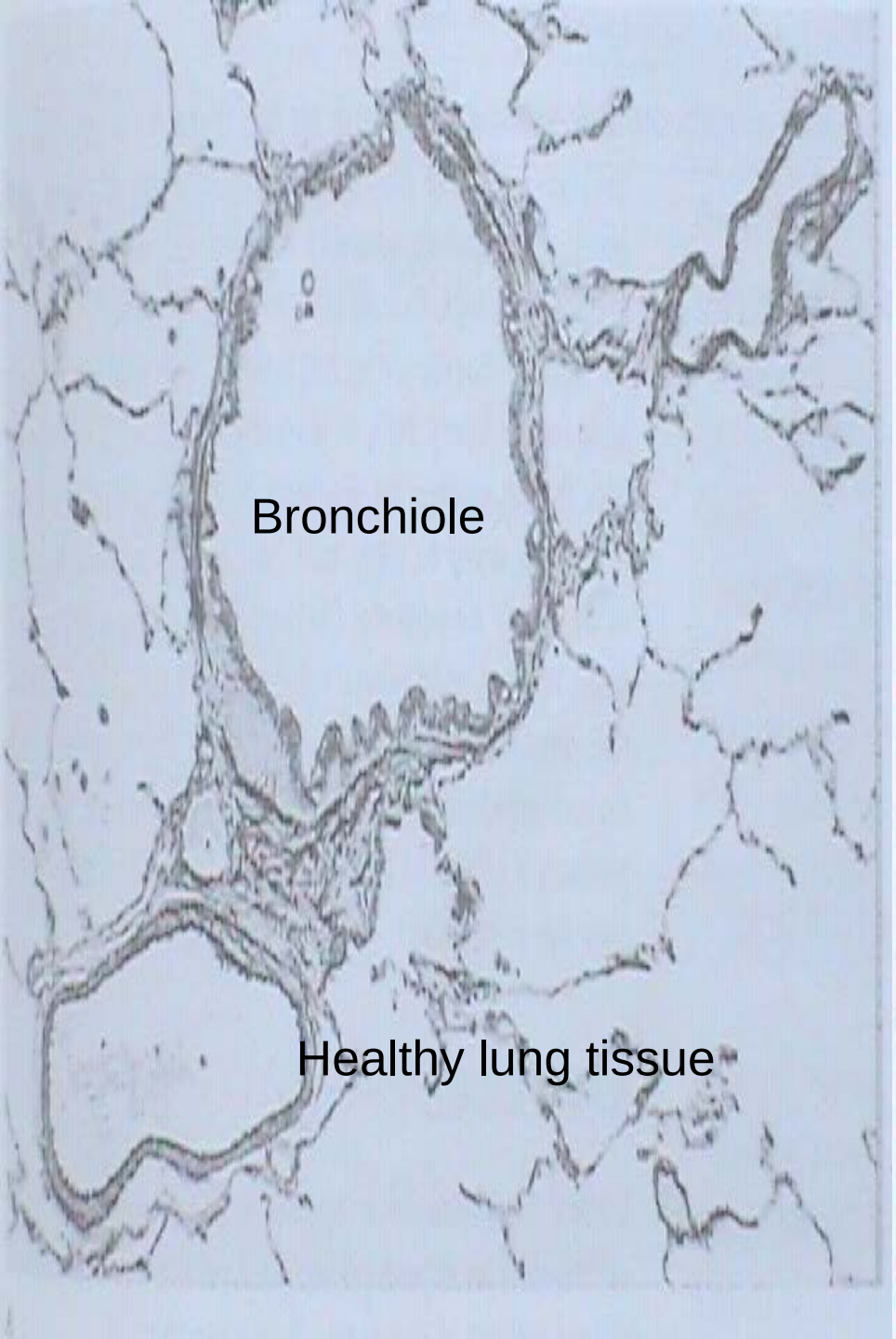
[1]CDC. MMWR 2013;*62*(16):305-307

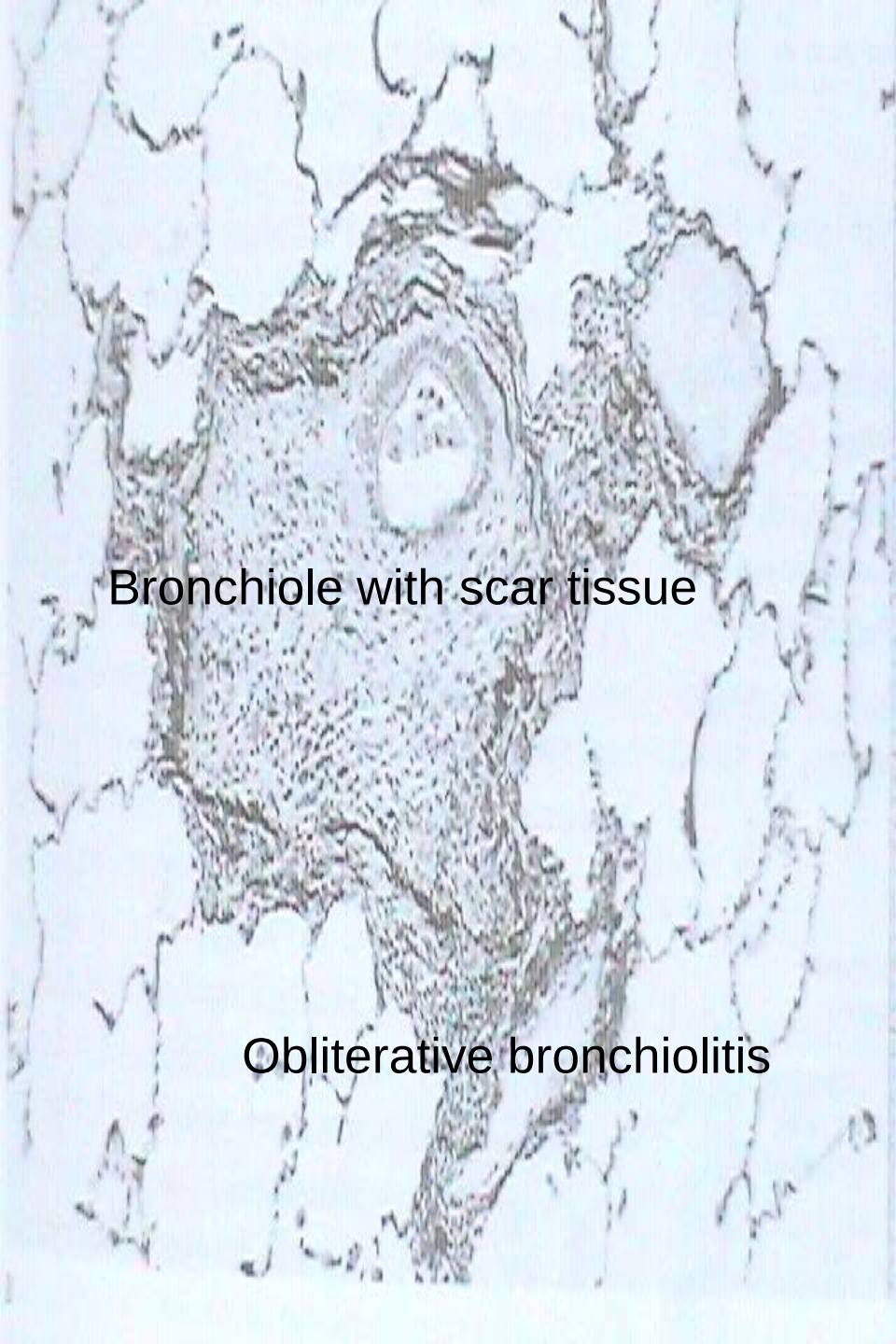
Obliterative bronchiolitis

- Severe lung disease
- Cough and shortness of breath on exertion
- Fixed airways obstruction
- Not responsive to medical treatment such as bronchodilators
- Misdiagnosis common

Spirometry test

Bronchodilator (albuterol inhaler)

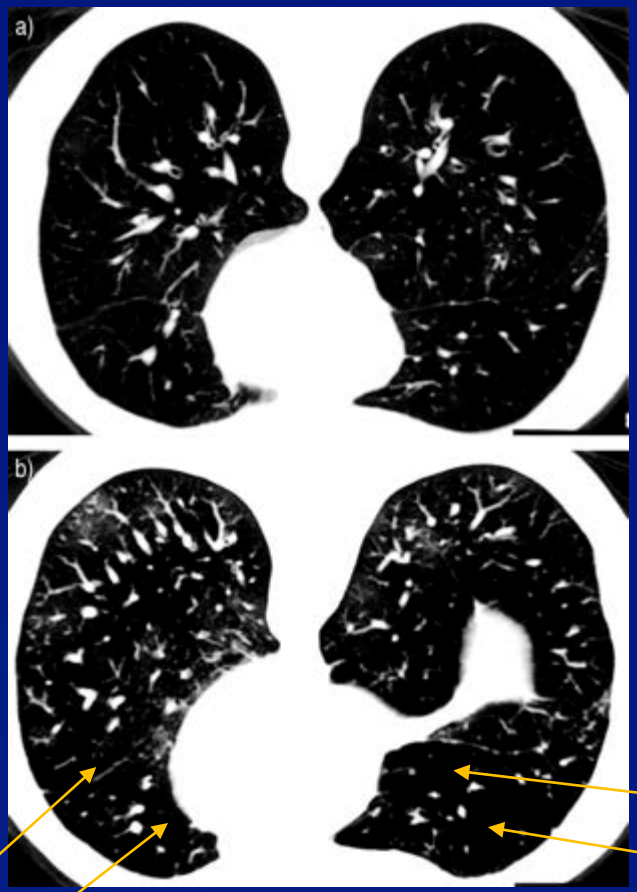

Bronchiole
Healthy lung tissue


Bronchiole with scar tissue
Obliterative bronchiolitis

High-resolution computerized tomography (HRCT) scans of chest

Inspiratory view

Expiratory view



Causes of obliterative bronchiolitis

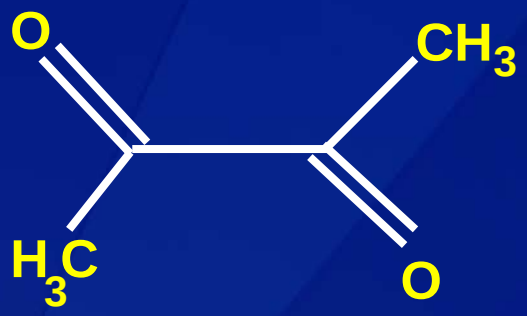
- Post-organ transplant
- Toxic gas inhalation
- Mineral and organic dusts
- Viral and bacterial infections
- Connective tissue diseases
- Flavoring chemicals (e.g. diacetyl)

Occupational obliterative bronchiolitis

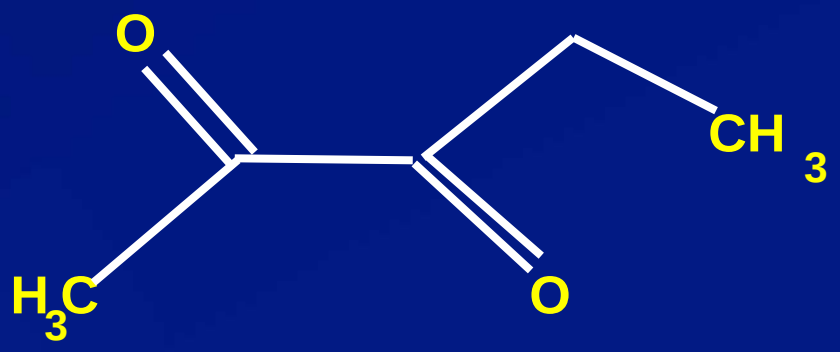
- Microwave popcorn workers and flavoring industry workers
- Diacetyl (2,3-butanedione) a common exposure across these industries
- 2,3-pentanedione, a diacetyl substitute, has similar toxicity as diacetyl in animals

Alpha-diketones

Diacetyl
(2,3-butanedione)



2,3-Pentanedione



Flavored Food Products

- **Cake mixes**
- **Flour**
- **Margarines**
- **Diary products**
  - Cheese and yogurt
- **Snack foods**
  - Cookies, soft spreads, chips, crackers
- **Soft drinks**
- **Coffee**

Other Flavoring-Related Health Hazard Evaluations

- Microwave popcorn
- Flavoring manufacture
- Snack food production (potato chips, corn chips)
- Cream cheese manufacture
- Bakery mix production
- Pet food manufacture
- Commercial kitchens

Cookie Manufacturing

- Report in 2012 medical journal of four workers in Brazil developing obliterative bronchiolitis
- Males, aged 24 to 27 years old
- Used artificial butter flavorings in preparation of dough

Cavalcanti et al. J Bras Pneumol 2012;*38*(3):395-399

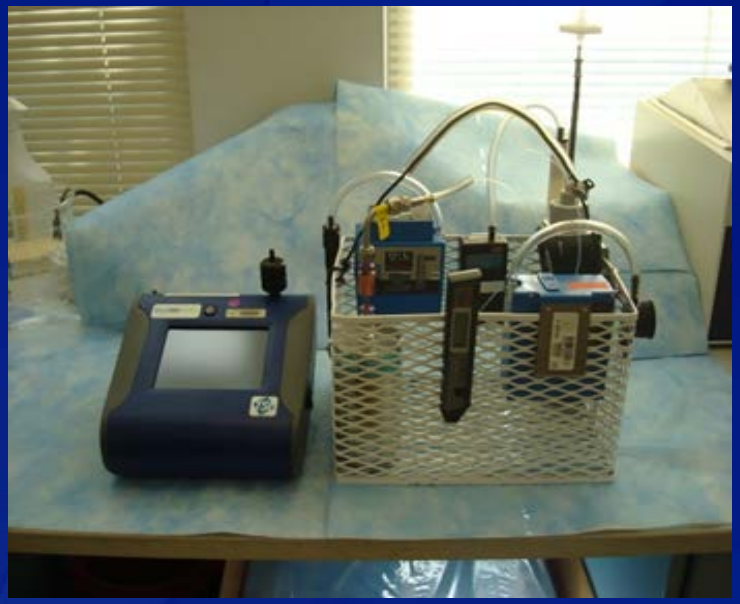
Food Manufacturing

Industry	NAICS Code	Employed June 2015
Food manufacturing	311	1.5 million
Bakeries and tortilla manufacturing	3118	296,658
Other food manufacturing	3119	195,048
Diary product manufacturing	3115	137,725
Sugar and confectionery product manufacturing	3113	69,469
Coffee and tea manufacturing	311920	19,897
Beverage industry	3121	214,863

Source: http://www.bls.gov/cew/apps/table_maker/v4/table_maker.htm#type=1&year=2015&qtr=2&own=5&ind=311920&supp=0

Coffee Processing Facility

Industrial hygiene survey at coffee processing plant



Area basket set-up

Personal air sampling set-up

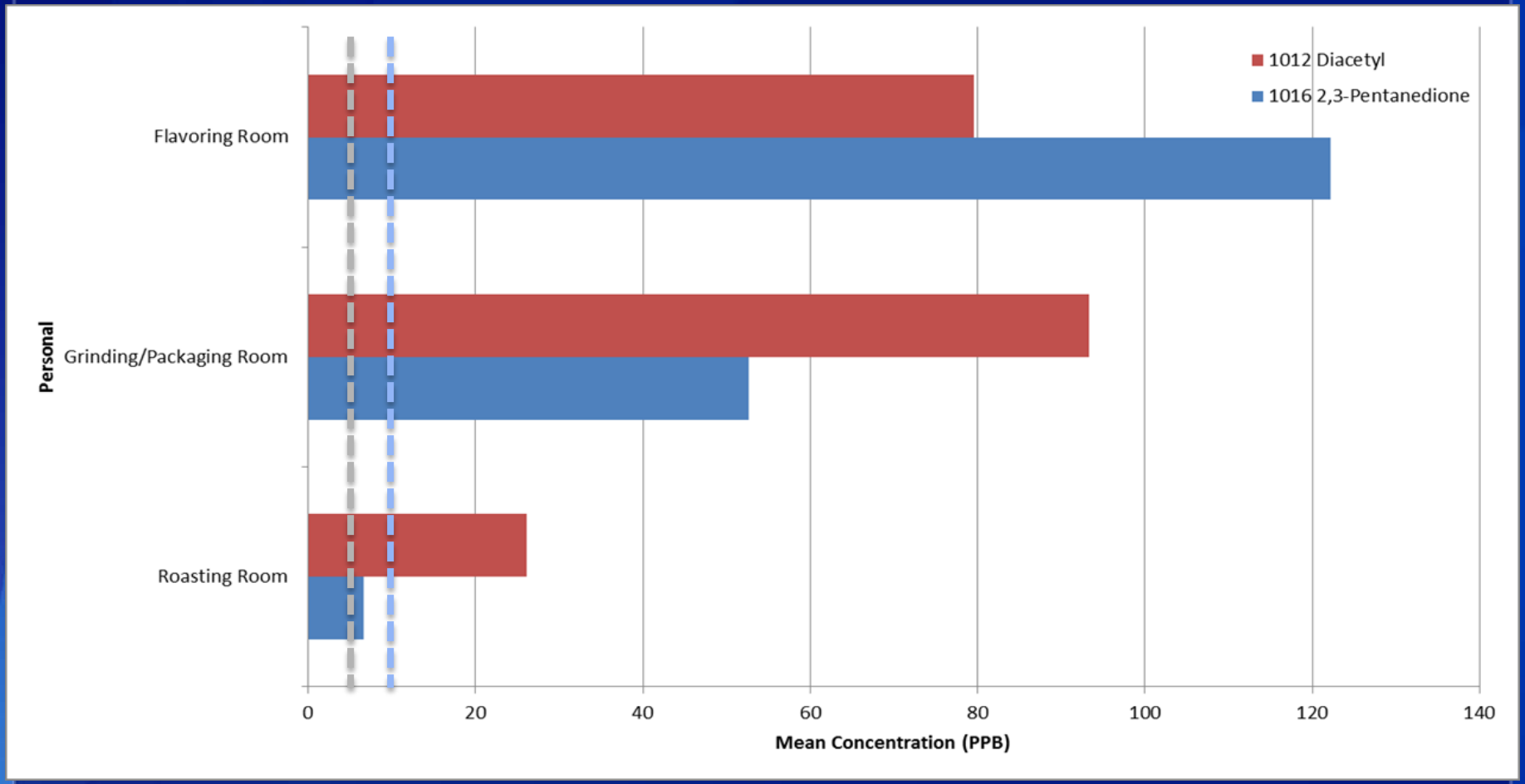
NIOSH proposed exposure limits for diacetyl and 2,3-pentanedione

- **8-hour time-weighted average exposure**
  - 5 parts per billion (ppb) for diacetyl
  - 9.3 ppb for 2,3-pentanedione

- **15-minute short-term exposure limit**
  - 25 ppb for diacetyl
  - 31 ppb for 2,3-pentanedione

NIOSH [2011a]. Draft criteria for a recommended standard: occupational exposure to diacetyl and 2,3-pentanedione. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 20XX-XXX. August 12, 2011 External Review Draft [http://www.cdc.gov/niosh/docket/archive/pdfs/NIOSH-245/0245-081211-draftdocument.pdf].

Mean personal diacetyl and 2,3-pentanedione concentrations by work area



NIOSH proposed recommended exposure limit or diacetyl: 5 ppb for an 8-hour time-weighted average

NIOSH proposed recommended exposure limit for 2,3-pentanedione: 9.3 ppb for an 8-hour time-weighted average

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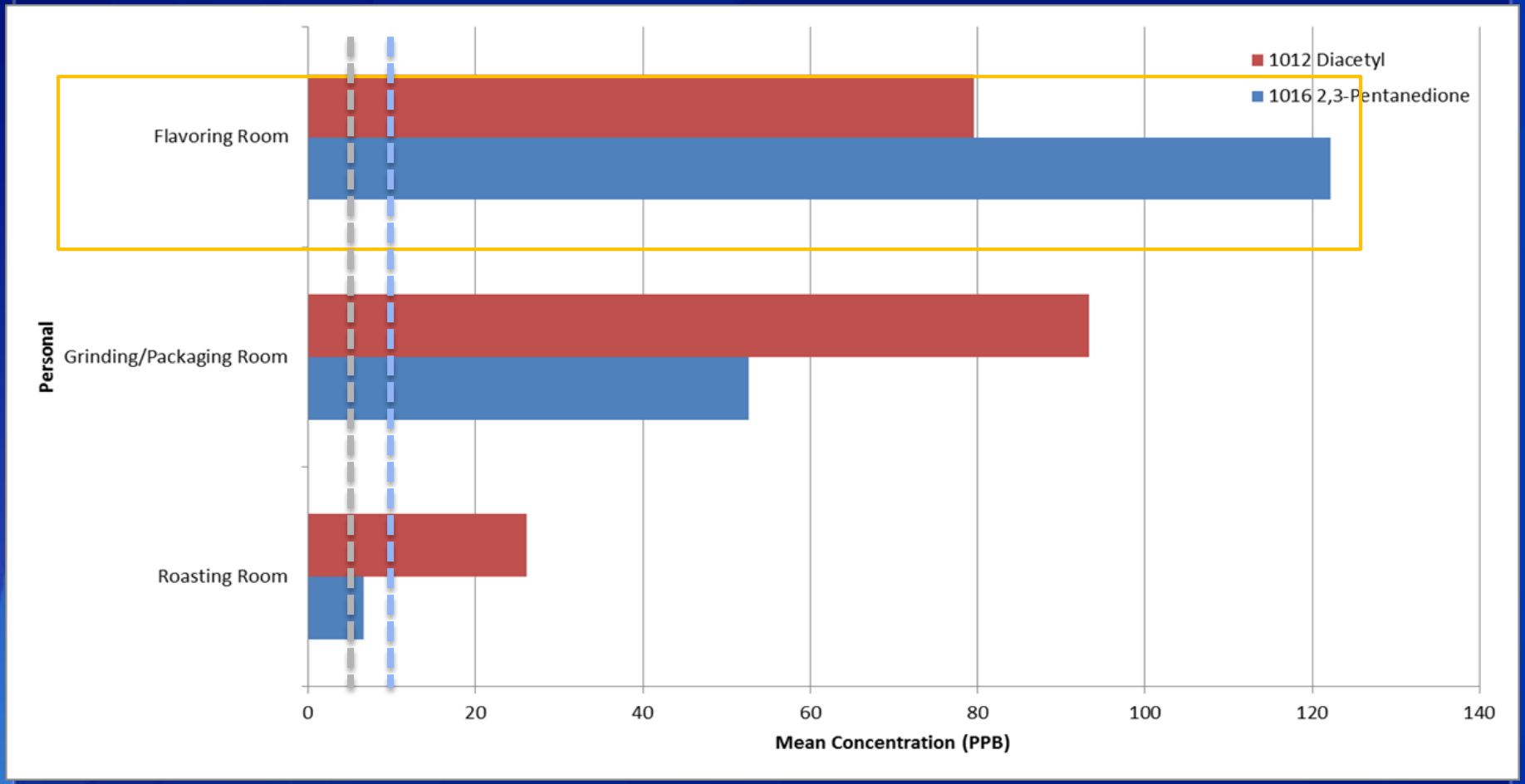

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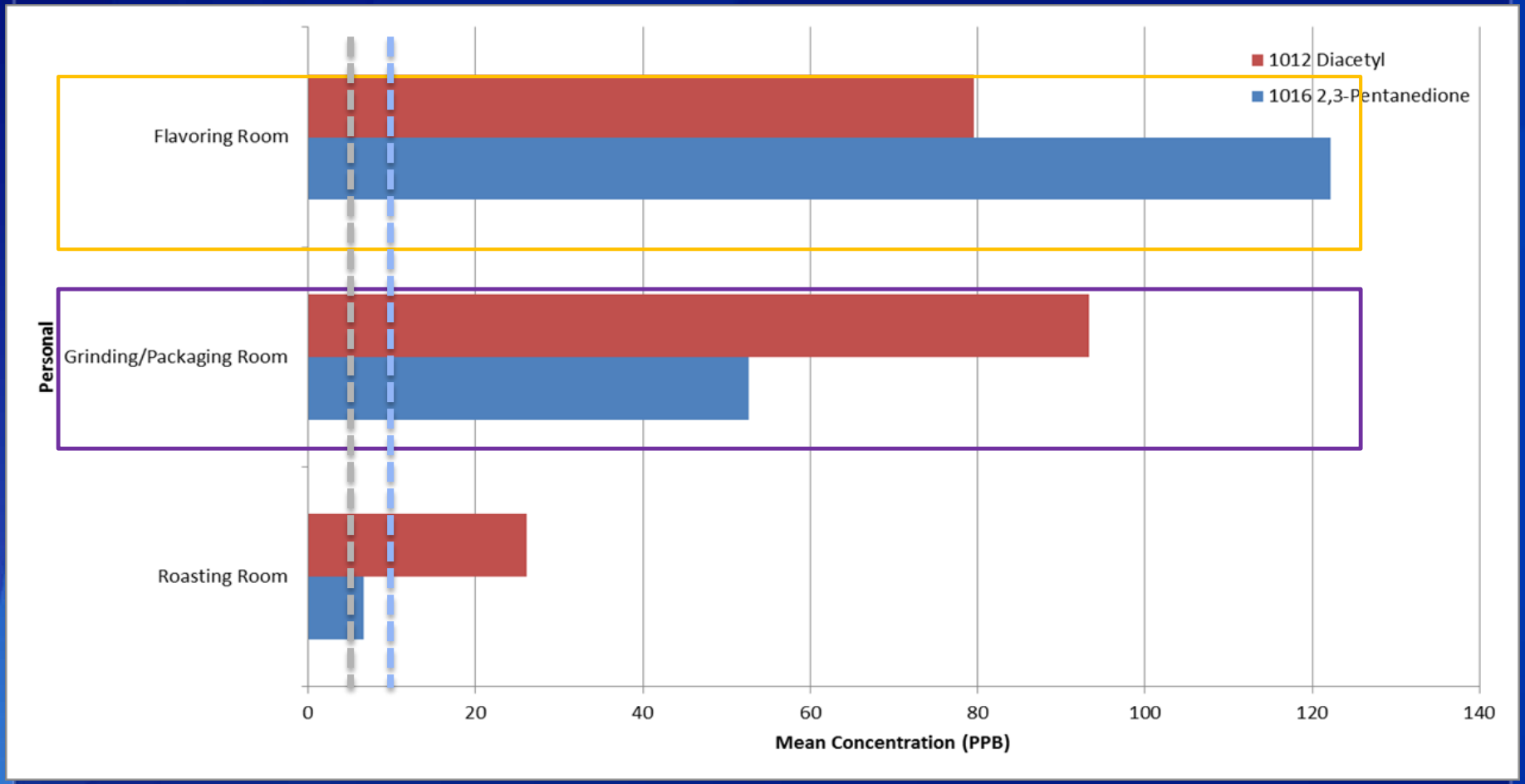

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Medical survey at coffee processing facility

- Interviewer-administered questionnaire
- Spirometry with bronchodilator
- Mannitol challenge if normal spirometry
- Total IgE
- Specific IgG and IgE for green coffee beans, coffee, and castor beans

Spirometry testing equipment

Green coffee beans in burlap bag

Bailey et al. AJIM 2015; 58:1235-1245

Medical survey demographics

- 75 (88%) participants
- Males (68%)
- Hispanic (69%)
- Average age - 35 years old
- Average tenure - 2.9 years (median 1.3 years)
- 49 (54%) participants were current or former smokers

Bailey et al. AJIM 2015; 58:1235-1245

Medical test results

- **7/69 had abnormal spirometry**
- **5/45 had increased sensitivity to mannitol**
- **Specific IgE: 1/60 to castor beans**
- **Specific IgG (N=60)**
  - 60 to green coffee beans
  - 57 to roasted coffee
  - 52 to castor beans

Bailey et al. AJIM 2015; 58:1235-1245

Employee prevalences compared to general population

- 2.7-fold excess (95% CI 1.2-6.4) of spirometric obstruction
- 1.6-fold excess (95% CI:1.0-2.4) of shortness of breath on exertion

Bailey et al. AJIM 2015; 58:1235-1245

Exposure indices related to health

- **Mean FEV1/FVC ratio decreased in high exposed workers compared to those who had not spent time in the grinding/packaging room or flavoring room (77% vs. 83%, p=0.01)**

- **Spending time in the roasting room compared to rest of the plant**
  - Sinus trouble OR 4.2
  - Burning eyes OR 4.4
  - Wheezing OR 3.4
  - Trouble breathing OR 3.9

Bailey et al. AJIM 2015; 58:1235-1245

Conclusions: coffee processing HHE

- Workers at this facility are at risk of obliterative bronchiolitis
- High exposure to diketones in both flavored and unflavored coffee production
- Company may have cases of work-related asthma
- Exposure to coffee dust and smoke in roasting room responsible for some mucous membrane and respiratory symptoms

Conclusions: coffee processing HHE

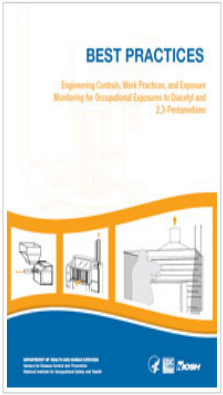
- **Combined alpha-diketone exposure during grinding/packaging unflavored coffee comparable to flavored coffee**
- **Interventions needed**
  - Engineering controls
  - Administrative controls
  - Hazard communication
  - Respiratory protection
  - Medical surveillance program

The National Institute for Occupational Safety and Health (NIOSH)

Best Practices: Engineering Controls, Work Practices, and Exposure Monitoring for Occupational Exposures to Diacetyl and 2,3-Pentanedione

DHHS (NIOSH) Publication Number 2015-197 **July 2015**

Workers who handle diacetyl or work in areas where diacetyl exposure occurs are at risk of developing severe lung disease if their exposures are not properly controlled. The National Institute for Occupational Safety and Health (NIOSH) has developed guidance in a variety of areas to reduce workers' exposures to diacetyl through engineering controls, best work practices, and techniques for monitoring airborne diacetyl exposures. Although these guidelines emphasize diacetyl, they can be applied to reduce exposures to diacetyl substitutes such as 2,3-pentanedione and other alpha-diketones.



Best Practices: Engineering Controls, Work Practices, and Exposure Monitoring for Occupational Exposures to Diacetyl and 2,3-Pentanedione [PDF - 1.5 MB]

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http://www.cdc.gov/niosh/docs/2015-197/default.html

Coffee Processing
Health Hazard Evaluations

- **12 health hazard evaluations at coffee processing companies**
  - Most do not flavor their coffee
  - Some have coffee cafés at their coffee processing facility or at a different location
  - Requestors
    - Expressed concern about potential exposures that could cause lung disease
    - Interested in air sampling that can guide preventive interventions
    - Open to lung function testing

Industrial Hygiene & Ventilation Survey

- TWA personal and area sampling
- STEL personal and area sampling
- Task-based sampling
- Real-time sampling
- Carbon monoxide and carbon dioxide
- Ventilation assessment

Medical Survey

- Health questionnaire
- Spirometry and bronchodilator
- Impulse oscillometry
- Exhaled nitric oxide

Spirometry testing

Impulse oscillometry
Source: http://www.carefusion.com/our-products/respiratory-care/pulmonary-function-testing/ios-spirometry

NIOX MINO® to measure exhaled nitric oxide

Updated the NIOSH Coffee Processing Facilities Webpage

Main Points

Obliterative bronchiolitis

Alpha-Diketones

Air Sampling and Analysis

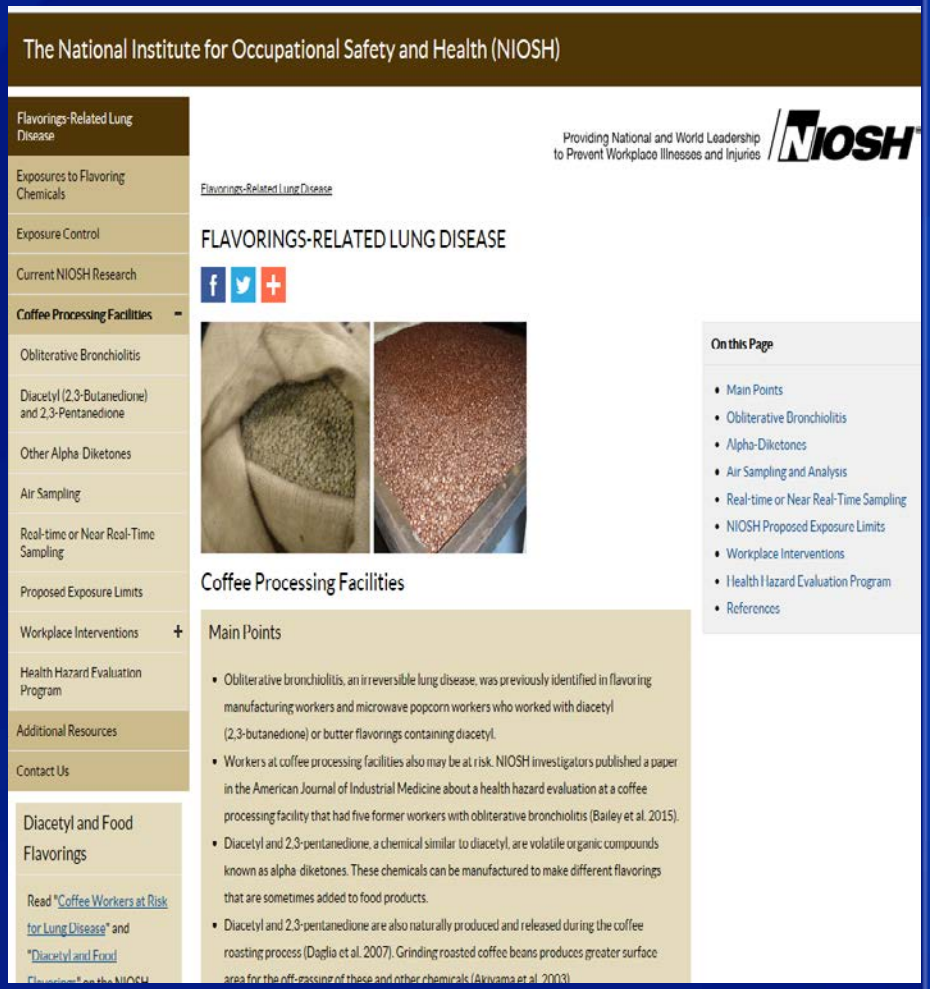
Real-time or Near Real-time Sampling

NIOSH Proposed Exposed Limits

Workplace Interventions

Health Hazard Evaluation Program

References



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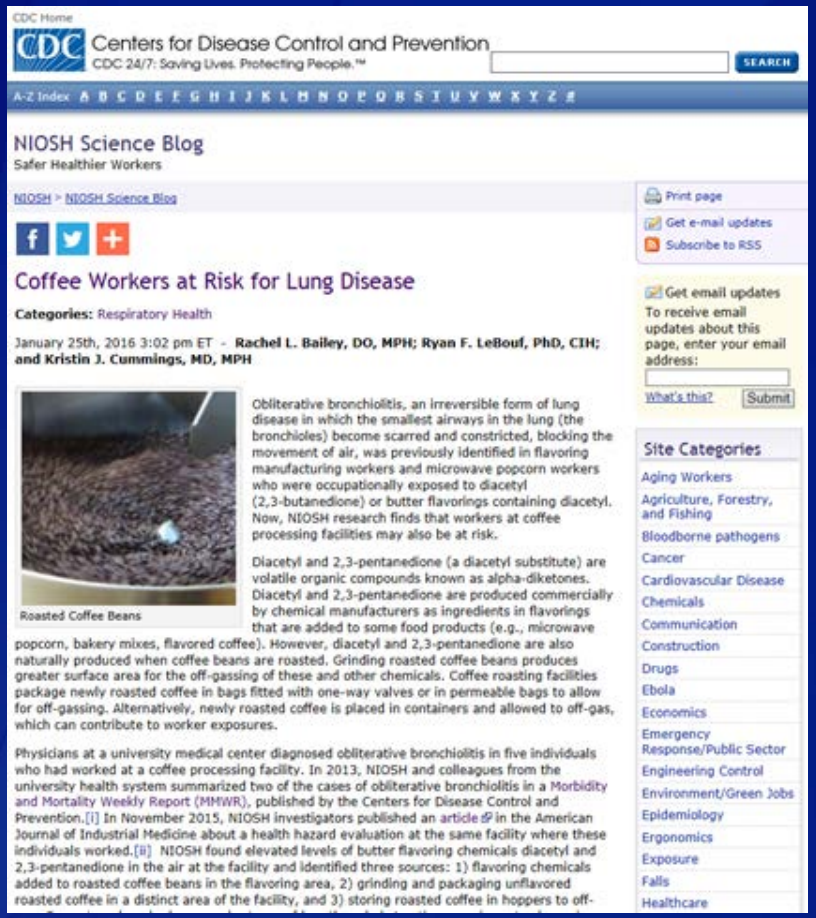

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Coffee Workers at Risk for Lung Disease

Categories: Respiratory Health

January 25th, 2016 3:02 pm ET - **Rachel L. Bailey, DO, MPH; Ryan F. LeBouf, PhD, CIH; and Kristin J. Cummings, MD, MPH**

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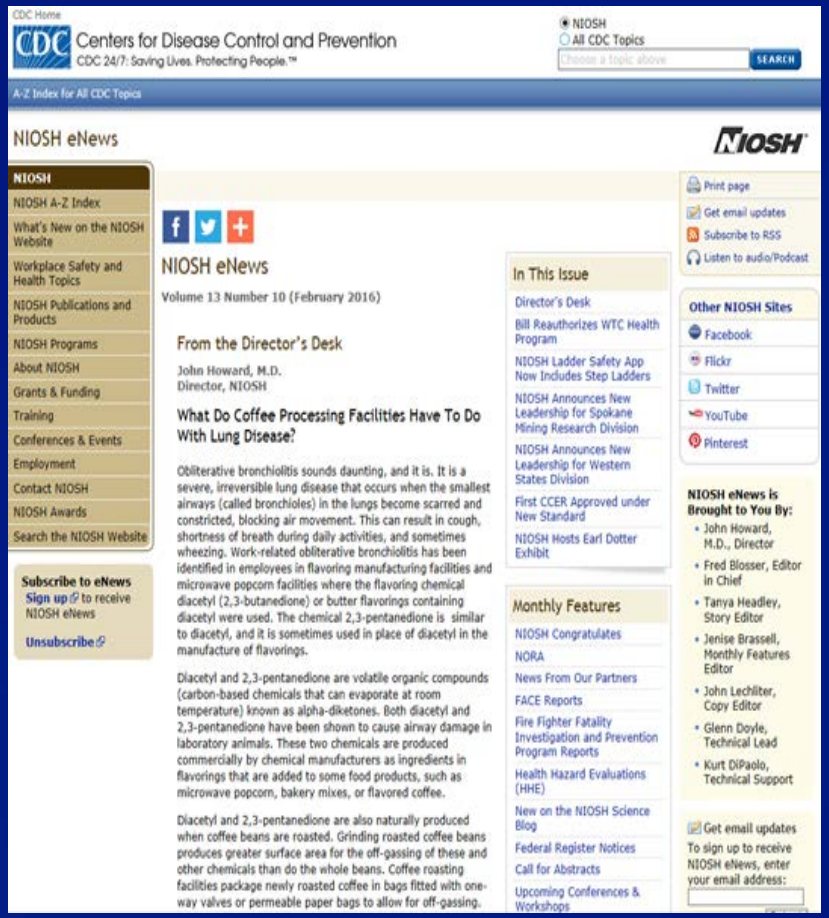
Roasted Coffee Beans

Obliterative bronchiolitis, an irreversible form of lung disease in which the smallest airways in the lung (the bronchioles) become scarred and constricted, blocking the movement of air, was previously identified in flavoring manufacturing workers and microwave popcorn workers who were occupationally exposed to diacetyl (2,3-butanedione) or butter flavorings containing diacetyl. Now, NIOSH research finds that workers at coffee processing facilities may also be at risk.

Diacetyl and 2,3-pentanedione (a diacetyl substitute) are volatile organic compounds known as alpha-diketones. Diacetyl and 2,3-pentanedione are produced commercially by chemical manufacturers as ingredients in flavorings that are added to some food products (e.g., microwave popcorn, bakery mixes, flavored coffee). However, diacetyl and 2,3-pentanedione are also naturally produced when coffee beans are roasted. Grinding roasted coffee beans produces greater surface area for the off-gassing of these and other chemicals. Coffee roasting facilities package newly roasted coffee in bags fitted with one-way valves or in permeable bags to allow for off-gassing. Alternatively, newly roasted coffee is placed in containers and allowed to off-gas, which can contribute to worker exposures.

Physicians at a university medical center diagnosed obliterative bronchiolitis in five individuals who had worked at a coffee processing facility. In 2013, NIOSH and colleagues from the university health system summarized two of the cases of obliterative bronchiolitis in a Morbidity and Mortality Weekly Report (MMWR), published by the Centers for Disease Control and Prevention.[i] In November 2015, NIOSH investigators published an article in the American Journal of Industrial Medicine about a health hazard evaluation at the same facility where these individuals worked.[ii] NIOSH found elevated levels of butter flavoring chemicals diacetyl and 2,3-pentanedione in the air at the facility and identified three sources: 1) flavoring chemicals added to roasted coffee beans in the flavoring area, 2) grinding and packaging unflavored roasted coffee in a distinct area of the facility, and 3) storing roasted coffee in hoppers to off-



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Volume 13 Number 10 (February 2016)

From the Director's Desk

John Howard, M.D.
Director, NIOSH

What Do Coffee Processing Facilities Have To Do With Lung Disease?

Obliterative bronchiolitis sounds daunting, and it is. It is a severe, irreversible lung disease that occurs when the smallest airways (called bronchioles) in the lungs become scarred and constricted, blocking air movement. This can result in cough, shortness of breath during daily activities, and sometimes wheezing. Work-related obliterative bronchiolitis has been identified in employees in flavoring manufacturing facilities and microwave popcorn facilities where the flavoring chemical diacetyl (2,3-butanedione) or butter flavorings containing diacetyl were used. The chemical 2,3-pentanedione is similar to diacetyl, and it is sometimes used in place of diacetyl in the manufacture of flavorings.

Diacetyl and 2,3-pentanedione are volatile organic compounds (carbon-based chemicals that can evaporate at room temperature) known as alpha-diketones. Both diacetyl and 2,3-pentanedione have been shown to cause airway damage in laboratory animals. These two chemicals are produced commercially by chemical manufacturers as ingredients in flavorings that are added to some food products, such as microwave popcorn, bakery mixes, or flavored coffee.

Diacetyl and 2,3-pentanedione are also naturally produced when coffee beans are roasted. Grinding roasted coffee beans produces greater surface area for the off-gassing of these and other chemicals than do the whole beans. Coffee roasting facilities package newly roasted coffee in bags fitted with one-way valves or permeable paper bags to allow for off-gassing.

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